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Maine Agricultural Experiment Station

ORONO

BULLETIN 241

AUGUST, 1915

WOOLLY APHID OF ELM AND JUNE BERRY

Endless paper 78

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This Bulletin contains an account of the common aphid forming leaf curl of the American Elm; and records the migration of this pest to the Juneberry.

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BULLETIN 241.

WOOLLY APHID OF ELM AND JUNE BERRY.*

(*Schizoneura americana* in part, of authors.)

EDITH M. PATCH.

Each season considerable concern is expressed by residents of Maine relative to certain deformations of elm leaves due to the work of aphids. Indeed so unattractive do young elms appear when heavily infested that it sometimes seems desirable to the owners to remove them from the lawn.

Several species cause distortions of these leaves, one of which is treated in this paper in such a manner as to outline the chief points in its life cycle.

Familiar to all observers of the American Elm are leaves one edge of which is rolled under as is shown in Figure 45. Such a curl constitutes a protective habitation for a family of aphids during their spring residence there.

The mother of the colony is a large plump, somewhat powdery aphid which, if examined in the sunlight under a lens, is found to have a greenish complexion. She passes the winter in the egg stage hidden in the crevices of the elm bark. In the spring, hatching from the egg just as the leaves are unfolding, she seeks a suitable one, punctures it with her beak and by remaining and feeding causes it to curl into the protecting roll. Early in June she has attained her full growth and the leaf in which she has been dwelling looks like the left hand leaf of Figure 45. She now gives birth to a large number of young, which, unlike their mother are born alive, not undergoing any external egg stage.

Her progeny are all females which upon attaining their growth give birth in turn to living young,—also all females.

*Papers from the Maine Agricultural Experiment Station: Entomology No. 79.

All the descendants of the original aphid or "stem-mother" as she is called, ordinarily remain in the same leaf and the curl becomes swollen and crowded with the numerous family. As each individual casts its skin several times in the process of its growth and as the discharge of honey dew is abundant, the curl after a time has a considerable amount of waste matter which causes it to look untidy within. Conditions are kept remarkably sanitary, however, by the aid of the waxy secretions of the aphids, particles of which cover the honey dew so that it rolls about in liquid pellets without drenching their bodies. These insects are further protected by the white waxy secretions which remain upon them rendering them impervious to moisture.

The earlier members of the family, including the stem-mother, are all wingless. Late in June, however, a generation matures with wings.

These winged individuals, or "spring migrants" as they are called, resemble the wingless generations previously mentioned in being all females, but they are smaller bodied and differ in various structures. Instead of remaining within the leaf with their wingless relatives these later forms take flight, seeking fresh vegetation for the establishment of the summer colonies. They are strong on the wing and fly to distances of at least three-fourths of a mile if they do not find a suitable location near at hand. When they desert the elm leaf which has furnished sap for their development they are "instinctively" led to an entirely different habitat, namely the Juneberry (*Amelanchier*) so common in Maine and variously known as Shad Bush, Service Berry, and locally as Sugar Plum.

When the migrant reaches one of these bushes it settles upon a leaf and soon afterward creeps to the underside where it remains quietly, ordinarily for the rest of its life. Before many hours it begins to give birth to young and continues this process for several days. The wee aphids, born on the underside of the Juneberry leaf, cling there for a little while without feeding and then walk down the stem of the plant. Sometimes a line of these can be seen trailing down "Indian file,"—little pellucid yellow specks so small that the observer almost requires a lens to detect them at all. The destination of these minute young is the underground stems of the Juneberry, where they settle in groups at some tender spot.

This, then, is the destined summer residence of the insect;—the little thing whose mother, grandmother and great grandmother grew up in the curl of a high swinging elm leaf, creeps under ground and sips Juneberry sap in the dark.

There is, perhaps, no bird migration more remarkable than the flight of a migratory aphid and the histories of many species of this family of insects have the thrill of a dramatic tale of adventure.

The summer colonies of our aphid of elm and Juneberry, like their spring antecedents, are composed only of females, the first generation being wingless and the body whitened by the secretions of the wax glands.

In the fall a generation of winged females is developed among the underground forms. These are the fall migrants and in appearance they are practically like the spring migrants. These leave the Juneberry and take flight to some American Elm.

Alighting on the bark, they seek a convenient crevice and give birth to minute young, part of which are egg-laying females and part males,—this being the only time in the life cycle of this insect that either of these forms appear. These tiny “true sexes” have no functional mouth parts,—their chapter in the life history being concerned merely with mating and providing for the deposition of the overwintering egg. Each female lays but a single egg which nearly fills her small body.

The egg is the closing page of the life cycle for the fall, and the opening one for the spring; because it is from this overwintering egg that the stem-mother hatches at the time of the bursting leaf buds, in season to form the curl of the elm leaf for the spring habitation used by her and her numerous progeny.

NATURAL ENEMIES.

There are several predaceous insects which frequent the elm leaf curls of this aphid. In Maine the most common ones are a capsid (*Camptobrochis nitens*), the flocculent larva of a coccinellid, and syrphus maggots. Some years these greatly reduce the numbers of this elm pest.

PREVENTIVE AND REMEDIAL MEASURES.

In a state where both elms and Juneberries abound as they do in Maine, we must expect this aphid to occur both in the curl of the leaves of the former and on the underground stems of the latter.



FIG. 45. Work of *S. americana* in part of authors: at left young roll containing stem female; at right, same species, old roll just deserted by migrants. Maine specimens.

Where the *Amelanchier* is planted for park or ornamental purposes within aphid flight of American Elm, it would seem desirable to try drenching the soil at the base of the shrub with Black Leaf 40 or other good tobacco decoction. Probably once about mid-July and again late in the month would be the most favorable time for this treatment as the colonies would be young and susceptible and likely to be nearer the surface than later in the season.

Young elms can be protected by spring sprays of tobacco decoction before the leaves become curled. Where large power sprayers are available old elms sprayed with drive nozzles could probably be cleaned of most of the infestation.

Dormant sprays of lime sulphur heavily coating the elm bark should be tested as to their efficiency in killing the over-wintering egg.

NOTES.

The species discussed in this paper under the title "Woolly Aphid of Elm and Juneberry" is the same species which is listed as CCC in the Habitat Key on page 184 of Bulletin No. 217 of this Station, and recorded on pages 268-271 of Bulletin No. 220.

As the alternate or summer host of this species has not previously been published, it seems desirable to state here the data upon which this life cycle is recorded.

On June 28, 1911, a collection of winged forms of this species from *Amelanchier canadensis* (L.) Medic. was made by Mr. William Woods and mounted by my assistant under the number 15-11. As *Prociphilus corrugatus* is commonly taking flight from the leaves of Juneberry late in June, I took it for granted that 15-11 was probably that species and did not examine the material until 1914 when I was startled to find that all this collection was *Schizoneura americana* of the elm leaf curl.

No additional data were obtained last year but on June 25, 1915, Mr. Woods brought into the laboratory about 30 migrants stating that they were abundant and occurring singly on the underside of the Juneberry leaves. Upon examination, I found these to be *Schizoneura americana* and as they had been collected about three-fourths of a mile from the nearest known elm, the situation was given immediate attention. I visited the place in the college woods where Mr. Woods had made his collection (50-15) and found the migrants resting upon the underside of the leaves of almost all of the numerous Juneberries in that vicinity, and did not find them settling upon other vegetation there. Upon some of the Juneberry leaves the minute yellowish young of the migrants were found, and it was an easy matter to locate on the underground stems of these shrubs, the colonies of young, already grouped about some favorable spot and covered by a slight waxy secretion.

Three young Juneberries were potted and brought into the laboratory. Migrants were removed from elm curl and caged with these plants. They settled on the ventral side of the leaves and remained there several days giving birth to their young which sought the underground stem of

the accepted plant. Of course, since these plants were taken from the open, there was every possibility that their roots might have been infested also in the field. But fortunately one of the three plants was kept moist under glass and upon this the progeny of the migrants colonized on the stem well above ground where there was no danger of their being confused with field material. Some of the colony were still alive 14 days later, but they did not thrive as did the underground settlements.

On Checkerberry Hill near Orono a solitary Juneberry not more than eighteen inches high was found with several migrants on the underside of its leaves. As this plant was about three-quarters of a mile from the nearest known elm, the record is interesting.

June 28, near Orono, 415 of these migrants were counted resting on the under surface of leaves of a single large Juneberry situated between two large elms. This number was only a part of the migrants present as those on the upper leaves could not be counted from the ground.

During the week of June 27, I spent parts of several days watching some small Juneberries on the river bank ledges near Orono. The migrants from elm were present and others alighted every now and then. I saw their young trailing down the stem toward the ground, and found colonies on the underground stems here as in the college woods.

For the most part but one migrant occurred on a leaf, but where leaf curls removed from elm were placed under caged Juneberries on the ledge, as many as 16 migrants were found on the ventral surface of a single leaf. Four other kinds of plants chanced to be under the same cage and it was interesting to record that not a single migrant was found on the under surface of the leaves of any of these. One was observed walking restlessly across the top of a goldenrod leaf, but it did not remain there.

As will be seen from the date of the publication, this paper goes to press before the fall migrants are collected from Juneberry; and the statement in the life history account that the fall migration to the elm is from Juneberry is based only upon what seems to be the inevitable sequel to the behavior of the spring migrants and their progeny on the Juneberry. Knowing the summer host and that migrants seek the elm in the fall, the circumstantial evidence seems logically sufficient.

The observation here recorded open up an interesting series of questions in regard to this widely distributed elm leaf species. Does this insect occur on the elm only where that tree is within aphid flight of *Amelanchier*? If not, what summer host is accepted for such localities? Are there circumstances where the elm, alone, is able to provide for a continuation of this species? Does it occur on the roots of trees or shrubs botanically related to the Juneberry and has it in such circumstances ever been confused with *lanigera*?

In connection with the last question it might be stated that the wax gland areas of the summer root forms are different from those of *lanigera* and would doubtless serve as a sufficient means of separating

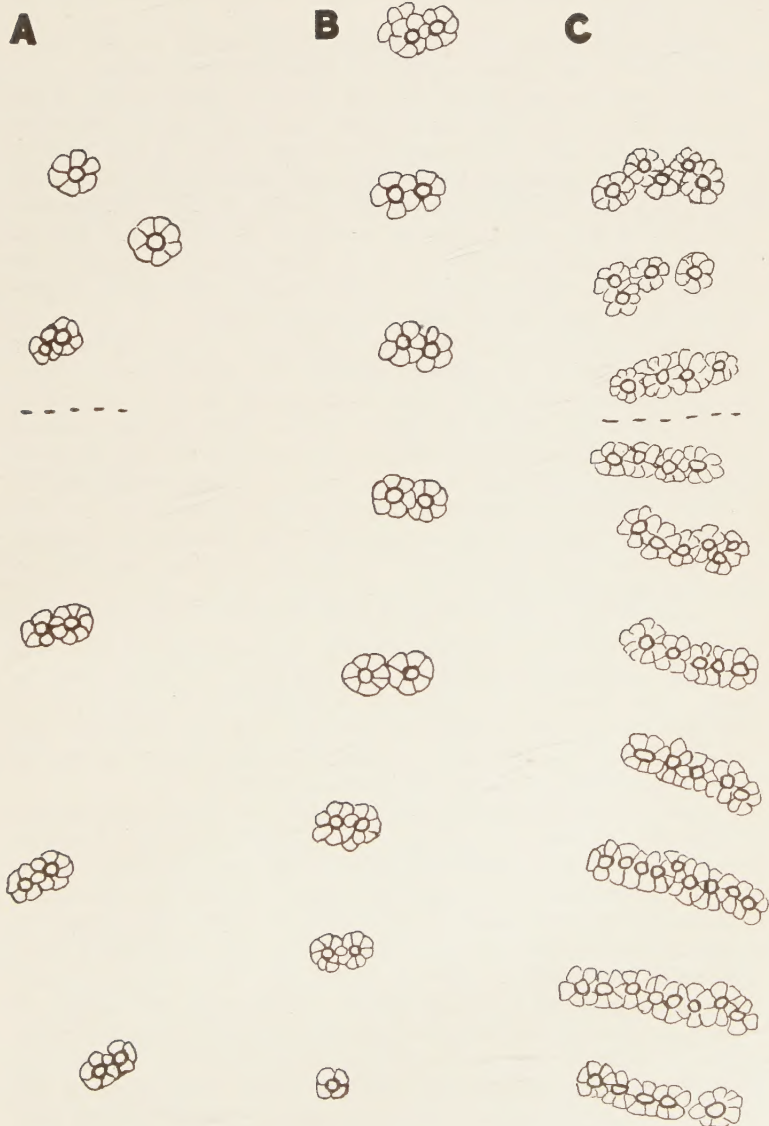


Fig. 46. Wax gland areas of nymphs of *S. americana* taken from underground stem of Juneberry, July 13, 1915. A. and B., those of one of the two dorsal lines. A, from head and thorax. B, from abdomen. C, lateral wax glands of thorax and abdomen.

these two species should they ever be found to occur upon the roots of the same trees.

Schizoneura americana is a name which until recently has been commonly applied to two distinct species by American entomologists.

One of these species inhabits the leaf cluster or aphid rosette of the American Elm.* This migrates to apple, several varieties of mountain ash (*Pyrus sp.*) and to hawthorn (*Crataegus*), where it was familiar as *lanigera* long before its identity with the aphid of the elm rosette was suspected. The life cycle of this species so far as personally ascertained by the writer is recorded in Bulletin No. 217 of this Station. The admirable publication by Mr. A. C. Baker should be consulted by everyone studying this insect. (1915. The Woolly Apple Aphis. Report No. 101, U. S. Dept. Agric. Office of the Secretary).

The other species to which the name *Schizoneura americana* has been commonly applied is the aphid discussed in this present paper. Since the name *lanigera* takes care of the rosette species on elm as well as on apple, *S. americana* seems to be left free for the aphid curling or rolling the leaf of the American Elm. Riley's description of the leaf deformations caused by *S. americana*† seem to indicate clearly enough that he originally applied this name to both these species as his successors have certainly done until recently; and the synonymy "*schizoneura lanigera* (*americana* in part, of authors)," correctly designates the "rosette aphid" of the elm.

* * * * *

The writer has observed and previously recorded migrants from leaf curl upon mountain ash (*Pyrus sp.*) in company with those from the rosette. The mountain ash concerned with that record was very near elms and whether the presence of leaf curl migrants upon that tree was accidental or whether their progeny will accept its roots as they do those of the Juneberry still remains to be ascertained.

The writer's first announcement of the migration of *lanigera* from elm to apple (Science Vol. 36, pp. 30-31) was a record of migrants from elm leaf curl establishing a successful colony upon apple seedlings. From the fact that subsequent successful migrations to apple have been from rosettes and not curls, there seems to be a possibility that rosette migrants may have been present accidentally in the curls which were collected in the South and sent to Maine, and that they were really the progenitors of the successful colony. Where curls and rosettes are present on the same tree such a mixture of the winged forms sometimes happens. Whether some southern elms support normally an elm curl form of *lanigera* or whether that initial record will stand as unique and without subsequent verification as to the type of the deformation concerned, remains to be seen.

* Figs. 70 and 71, Bulletin 217. Maine Agric. Exp. Sta.

† "Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but, according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves."

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN 242

OCTOBER, 1915

PINK AND GREEN APHID OF POTATO

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*Absent on leave.

BULLETIN 242.

PINK AND GREEN APHID OF POTATO.*

(*Macrosiphum solanifolii* Ashmead).

EDITH M. PATCH.

The need for the study of the habits and life cycles of aphids, before a satisfactory basis can be obtained for remedial recommendations, is apparent to anyone familiar with the complexities of such a problem.

Those species that accept but one food plant, depositing their winter eggs upon it and passing their whole life cycle there, usually present no difficulties greater than those of other insect pests and are even easier to combat than many.

But those aphids that select one kind of plant upon which to pass the fall, winter and spring and a different kind for the summer generations, frequently so change their manner of life to suit the two environments that it behooves us to look sharply lest we miss a link here or there in their life cycles, but even here we need reckon with only two plants.

When, however, in addition to two favorite food plants, a species of aphid will accept others not botanically related, the problem is complicated by a new element for every different food plant.

This latter condition is the case with the pink and green aphid of potato. When work with this species was first undertaken at the Maine Agricultural Experiment Station, the only food plants recorded for it were two plants belonging to the night-shade family,—the “pepper vine” and the potato. A glance at the food plant list in this bulletin will show that the insect concerned has really a broad taste in botanical juices and will imbibe freely of the sap from numerous sources, each of which deserves consideration in economic work with this aphid.

*Papers from the Maine Agricultural Experiment Station Entomology No. 81.

LIFE HISTORY.

The pink and green aphid of potato is found in the spring upon rose bushes, feeding on the succulent growth and especially abundant near the flower buds. Unlike many species of plant-lice, migration with this insect may occur through wingless as well as winged individuals. The winged ones take flight, and the others, if they are near enough, walk over to potato plants. This occurs in Maine ordinarily from the first to the middle of July, when a very few scattered individuals may be seen upon the potato. Upon this plant they seem to find conditions ideal for growth and increase enormously, often before the last of August covering the tender tips and blossom stalks thickly with their colonies. At this time a single female may produce more than 50 young in 2 weeks, and it takes, in warm weather, about 2 weeks after birth for a female of this species to attain maturity and begin to produce young. A glance at figure 48 will show the result of a heavy infestation of 14 days duration upon the potato plant.

By the middle of September the fall migration is over and the aphids have deserted the potato fields. The indoor studies with this insect indicate that when it leaves the potato it prefers the rose, but will colonize upon a variety of plants, part of which are common weeds. This seems more like a dispersal from the potato than a "return migration" in the sense this term is used with reference to those aphids which accept only two kinds of food plant—the first for the fall, the overwintering egg and the spring, and the second for the summer months. However, the rose seems to be the favorite and it is probable in Maine that this serves most commonly for the fall generations of the potato aphid. The last generation of the year consists in the wingless, egg-laying females and the winged males,—or the so-called "true sexes" which appear in Maine about September 20 and only at this one time, all the other generations consisting entirely of viviparous females. The insectary observations of 1907 showed that under indoor conditions, the true sexes may be produced and the overwintering eggs may be deposited on both potato and shepherd's purse. It is likely that this generation can be produced on other accepted food plants also. No evidence has been found in the field, however, that the true sexes or eggs occur normally upon the potato, for the aphids

leave that food plant earlier in the season when out of doors. In the insectary the eggs were placed indiscriminately on leaves and stalks. These are pellucid green at first and later become glistening brownish black.

It is not known upon how great a range of food plants this aphid will develop in the spring. In Maine it has never yet been collected during this season upon anything but rose, which would indicate that this is the favorite overwintering host plant and the one ordinarily chosen for the deposition of the egg in the fall.

On October 9, 1908, great numbers of winged viviparous females and winged males and wingless oviparous females were found on Japanese rose bushes on the Maine Campus. They were for the most part on the ventral surface of the leaves. The winged viviparous females were presumably the fall migrants and mothers of the true sexes.

The stem mothers or females hatching from the overwintering eggs, were abundant upon these same bushes the next May and by the thirteenth of the month were nearly mature and were feeding at the half-opened leaf buds. On June 3 the progeny of the first generation, or the stem mothers, consisted of mature alate and apterous viviparous females as well as immature aphids of both the second and third generation. Usually by the first of July only scattered colonies remain upon the rose and by this time the summer generation may be found upon the potato.

ECONOMIC SIGNIFICANCE.

During certain summers enormous numbers of the pink and green potato aphid have appeared over wide areas in Aroostook County, the vines being attacked to an injurious extent in the vicinity of Houlton and elsewhere. The colonies cluster thick on stem, leaf and blossom stalk, blighting the stems and drying the terminal leaves as is shown in figures 47 and 48. The time of severest attack apparently varies somewhat, but the infestation in Maine has not been excessive before early August and is over with before the middle of September. Under conditions favorable to aphid growth, an attack of less than two weeks' duration suffices to kill the potato stalk for a distance of 4 to 6 inches from the tip, and the growth of the tubers on plants thus weakened must necessarily be affected. Aside from

the direct weakening of the plant due to the loss of sap and the withering of the tissue, the danger to the health of a plant thus attacked by plantlice is considerable. Although exceedingly minute, the beak of the plantlouse makes a wound which becomes in a short time surrounded by a discolored area, readily detected by the unaided eye. As these wounds extend for some little distance into the plant, a favorable location for the entrance of bacterial or fungus disease is thus secured even where the infestation of plantlice is not excessive enough to wither the tips of the stalk. Moreover it is perfectly possible for insects to carry fungus spores from diseased to healthy plants. Where the plantlice are abundant the leaves are covered with honey dew which is soon attacked by a dark fungus, and which together with the molted skins adhering to the sticky substance, gives the leaves an unhealthy appearance and must interfere with their natural function.

DISTRIBUTION.

Macrosiphum solanifolii has been recorded from Canada, Florida, Maine and California, and from various intermediate localities. Apparently it might be expected to occur in any of our states.

DESCRIPTION.

Recognition characters: In general *Macrosiphum solanifolii* is a large species either green or pink. The apterous forms are somewhat inclined to drop from the plant when disturbed. The abdomen is not marked with dark, but is ordinarily clear in color either pink or green, though sometimes late in the season individuals may be found with a mottling part pink and part green. The mature forms are rather glistening, but in the stage previous to the last molt the insect usually has a mid-dorsal line of dark green or pink (according to the color of the individual) while the rest of the dorsum is paler by virtue of a very slight powdery deposit. This appearance is more noticeable in bright light. The beak is short, usually, not or barely reaching the second coxa, though certain collections have been taken with beaks a little longer. The cornicles are characterized by reticulations at the tip. This reticulation holds true for all the mature individuals,—alate and apterous viviparous females, oviparous

females, and males,—whether of the green or pink variety, and regardless of the food plant upon which they have developed. The cornicles of the immature individuals are not so marked. The antennae of the apterous females are a little swollen at the proximal part of III, where a few sensoria are placed; those of the alate females have the sensoria in a single row not extending to the distal tip of III. The wing veins are clear cut and well defined though slender.

The foregoing are the general recognition marks. There is no structural difference between the spring and the fall individuals great enough to lead one to think they might be different species; though there is a range in size, influenced by food plant or other conditions, great enough to cause hesitation in determining certain collections unless the progenitors are known. The measurements, therefore, in the following descriptions can only be taken as approximate.

Macrosiphum solanifolii. *Winged viviparous female, green variety*.—Head yellowish green. Beak typically barely reaching second coxa, though in some collections a little longer. Antennae, proximal segments pale green, distal segments dark; length of segments: III, .88 to .96 mm.; IV, .76 to .9 mm.; V, .64 to .72 mm.; VI, base .16 to .2 mm.; VI, spur .96 to 1.12 mm.; total length I to VI, 3.6 to 4.05 mm. III with single row of sensoria somewhat irregular in size numbering 18 or a few more or less, not extending to distal end. Prothorax and thorax light yellowish green, lobes brownish. Wings hyaline, veins dark brown, very slender and clear cut, stigma pale brown. Total wing expansion 8.1 mm. Legs with proximal part of femora and tibiae pale, tarsi and distal part of femora and tibiae dark. Tarsi .16 to .2 mm. Abdomen light green unmarked dorsally or ventrally. Cornicles, with proximal portion green and distal portion dark brown, imbricated for more than three-fourths its length but strongly reticulated at tip, cylindrical, length .95 mm. or about five times length of tarsus. Cauda light green, ensiform, length .48 mm. or about one-half length of cornicles. Total length of body to distal tip of cauda and exclusive of antennae 2.9 to 3.37 mm.

Winged viviparous female, pink variety.—Head light yellowish. Antennae with I and II light yellowish, rest dark. Sensoria as with the green variety. Prothorax and thorax light yellowish pink. Abdomen pale pink. Cornicles light yellow with tips dusky and strongly reticulated. Cauda pink. Measurements the same as with the green variety.

Apterous viviparous female.—Color either pink or green as with the winged viviparous form. Antennae, length of segments: III, .8 to .96 mm.; IV, .72 to .88 mm.; V, .56 to .72 mm.; VI, base .16 to .2 mm.; VI spur .96 to 1.2 mm.; total length of segments I to VI, average about 4.95 mm. III slightly swollen at basal third where 1 to 5 sensoria occur. Cor-

nicles .96 to 1.04 mm. in length, and strongly reticulated at tip about one-fifth the distance. Cauda .56 mm. Total length of body to distal tip of cauda and exclusive of antennae, 4.05 mm.

Apterous oviparous female.—Head pale, nearly white. Antennae with proximal joints pale, distal half dark. Length of segments: III, .68 to .88 mm.; IV, .56 to .68 mm.; V, .52 to .64 mm.; VI, base .16 mm.; VI, spur .96 to 1.04 mm.; total antennal length I to VI average about 3.6 mm. III with about 3 to 6 sensoria. Prothorax and thorax pale like head. Legs with femora and tibiae, proximal portion pale, distal portion dusky. Tarsi dark, .16 mm. long. Hind tibiae conspicuously darker and much swollen and thickly set with sensoria. Abdomen light salmon pink. Cornicles pale at base, distal half dark and reticulated at tip; length .6 to .8 mm. Cauda salmon pink, ensiform, length .32 to .4 mm. Total body length to tip of cauda, antennae excluded, 2.13 to 2.15 mm. The size of the hind tibiae of this form makes it readily distinguished from the apterous viviparous form and young, even to the unaided eye.

The pink variety has been described because these predominate among the oviparous females. The color scheme of the green and yellow forms can be determined merely by substituting these colors for the salmon pink of the individual described, the dark coloration being the same for all three.

Winged male.—Head and antennae dark brown. Length of antennal segments: III, .72 to .8 mm.; IV, .48 to .64 mm.; V, .48 to .6 mm.; VI, base .16 mm.; VI, spur 1.04 to 1.28 mm.; total antennal length I to VI, 2.93 to 3.60 mm. Sensoria numerous on III, usually none on IV, and an irregular row of them nearly the whole length of V. Prothorax and thorax dark brown. Wings hyaline, veins dark and very slender, stigma pale brown. Legs brown, darker at tips. Abdomen greenish or brown. Cornicles pale brown, dark distally and reticulated, cylindrical, .48 to .56 mm. long. Total body length exclusive of antennae and cornicles, 1.12 to 1.57 mm. The thorax is large and strong, the abdomen much shrunken, making the cornicles seem conspicuously long. The male is described from individuals taken in copulation, in order that no mistake as to the identity of the species might occur.

INDOOR STUDIES.

This potato aphid is amenable to laboratory or greenhouse conditions, being very easy to rear indoors. In 1907 successful colonies were reared by the writer on garden peas and shepherd's purse in the insectary, the insects being originally collected from potato. The notes concerning these follow:

July-October, 1907. By starting potatoes in the insectary often, the aphids were supplied with fresh plants which were colonized by the individuals deserting the leaves and stalks they had rendered sickly.

Buckwheat was sown among the potato plants in the insectary and about 200 young and clean plants of shepherd's purse were put into trays. Peas were also sown at the same time. By the time the buckwheat and peas were well up about 100 fresh potato plants were available, and the *M. solanifolii*, deserting the older potato stalks, colonized thoroughly the fresh potato vines, pea vines, and the shepherd's purse apparently with no preference. Both winged and wingless forms were found for the rest of the season rearing contented progeny upon potato, and shepherd's purse, and also upon the young pea vines. Except for stray individuals which, of course, would be found upon everything in the crowded insectary, the buckwheat remained apparently untouched for feeding purposes. Whether *M. solanifolii* would have accepted the blossom tips of the older buckwheat or not was not demonstrated, as the buckwheat, although it lived, did not make much growth. (On vigorous succulent buckwheat in the field a collection of apparently *solanifolii* was taken at Houlton, Me., Aug. 31, 1907.)

October 11, 1907. Insectary search showed the *Macrosiphum* eggs near some of the oviparous forms both upon potato and shepherd's purse (*Capsella Bursa-pastoris*.) Many of the eggs were the glistening brownish black of well hardened eggs but some were pellucid green, showing that they had very recently been deposited. They were upon the plants indiscriminately on leaves and stalks. Males and oviparous females were present upon both these plants.

The appearance of the oviparous females and the deposition of eggs with the uncaged material at practically the same time as that of the forms that had been prisoners for 2 months would indicate that these dates are about normal. In the insectary the dispersion from overcrowded potato stalks to fresh plants seemed to take place irregularly and not at any stated times, the condition of the infested plant apparently influencing these movements. The fact that they seemed to accept the fresh potato plants almost as readily as the peas or the shepherd's purse might seem to indicate that if a similar succession of new potatoes were supplied them in the field they might not seek another host even there. As it is a wholesale migration has taken place each of the seasons these plantlice have been under observation.

July 7, 1915. Specimens of *Macrosiphum solanifolii* were collected from about the flower buds of Japanese rose on the campus (72-15).

72-15 (a) July 7, mature apterous viviparous females collected from Japanese rose were placed on potato in the laboratory. Both the pink and the green varieties were used. These settled at once. July 13,—pink and green individuals both still feeding, and a vigorous colony of green nymphs present. July 20. Progeny of 72-15 (a) present in colonies of pink and green young.

72-15 (b) July 7,—a few alate viviparous females collected from Japanese rose were placed on potato plants in the laboratory. Both the pink and the green variety used. July 9,—one pink female with 4 pink young, one green female with several green young. July 13,—pink and green females still feeding, and pink and green nymphs numerous. July 19,—plant sickly but aphid colonies thriving. Nine mature apterous pink females (progeny of the alate forms of July 7 (72-15 (b)) removed to fresh potato plant under number of 72-15 (b) (b).

72-15 (b) (b) July 19,—9 mature apterous pink daughters of alates (collection 72-15 (b)) placed on fresh potato plant. August 2,—the progeny of aforesaid 9 individuals now number approximately 500. All are pink, 35 of these have attained their growth, 20 being winged and 15 apterous.

* * * * *

The descendants unto several generations, of 72-15 which had been collected from Japanese rose, were kept on a succession of fresh potato plants in the laboratory until about the middle of August, when both the winged and wingless aphids began to get restless. The infested plants were taken down to the insect greenhouse and left uncovered. Stems of cut Japanese rose were kept near them in jars of water.

On September 15, these potato plants still had numerous aphids upon them but many had left and established thriving colonies of progeny upon the rose cuttings; goosefoot, *Chenopodium album*; redroot pigweed, *Amaranthus retroflexus*; shepherd's purse, *Capsella Bursa-pastoris*; several varieties of cultivated asters; and sow thistle, *Sonchus oleraceus*.

Both winged and wingless viviparous mature females of both the green and pink color varieties were found feeding upon all

the plants listed in the foregoing paragraph and good colonies of young both pink and green, were also feeding readily upon all these plants. They were along the tender terminal stems, on fresh leaves or in the case of the asters particularly abundant upon the blossom petals.

Whether this aphid would accept so varied a diet immediately upon leaving the rose in the spring or not we do not know. After a summer upon potato it is apparently ready to play the role of a general feeder, judging from the wide range of food plants just recorded.

Maine collection data for eight seasons indicate that *solani-folii* prefers decidedly the rose in the spring and the potato in the summer, for it is commonly abundant upon these two and has not yet been conspicuous upon other vegetation here. There is however, no reason to suppose that any aphid will accept indoors a plant which it would not feed upon out of doors if conditions were favorable, and it might easily be present in small colonies without being detected.

FOOD PLANTS.

GRAMINEAE. Grass Family.

Zea mays L., Britton, W. E. 1913. 12th Rept. St. Ent. of Conn.

IRIDACEAE. Iris Family.

Iris sp. cultivated. Patch, Edith M., 1912. Me. Agr. Expt. Sta. Bul. 202.

Gladiolus sp. Patch, Edith M. 1912. Me. Agr. Expt. Sta. Bul. 202.

POLYGONACEAE.

Fagopyrum esculentum Moench. Buckwheat. Patch, Edith M. 1907, field collection, (16-07).

CHENOPODIACEAE. Goosefoot Family.

Chenopodium album L. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

AMARANTHACEAE. Amaranth Family.

Amaranthus retroflexus L. Redroot pigweed. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

CRUCIFERAE. Mustard Family.

Brassica Rapa L. Turnip. Patch, Edith M. 1905, field collection (62-05).

Capsella Bursa-pastoris (L.) Patch, Edith M. 1907. Me. Agr. Expt. Sta. Bul. No. 147, p. 244.

ROSACEAE. Rose Family.

Pyrus malus (Hill). Apple. Baker, A. C. 1915. Letter of May 4, "Last season we found the green variety feeding on apple. . . . I had noted the species previously on apple in the pink form, as well as the pink one on potatoes."

Rosa species. Patch, Edith M. 1914 (1915). Bul. 233. Me Agr. Expt. Sta. Japanese rose; 1915, Notebook record for July 13, apterous viviparous form on wild rose.

LEGUMINOSAE. Pulse Family.

Phaseolus vulgaris L. Bean. Patch, Edith M. 1905, field collection (53-05).

Pisum sativum L. Garden pea. Patch, Edith M. 1907. Me. Agr. Expt. Sta. Bul. No. 147, p. 244. Greenhouse test with progeny from potato colonies.

SOLANACEAE. Nightshade Family.

Physalis species. Ground cherry. Webster, R. L. 1915. Iowa Bulletin 155.
Solanum jasminoides Paxt. Pepper vine. Ashmead, Wm. 1882. Canadian Entomologist.

Solanum melongena L. Egg plant. Chittenden, F. H. 1915. In letter of June 22 "Collected at Washington between June 17 and 21, 1915."

Solanum tuberosum L. Potato. Fletcher, James. 1905. Ann. Rept. on Expt. Farms for 1904: Patch, Edith M. 1907-1915. Bulletins of Me. Agr. Expt. Sta.: Davis, J. J. 1911, Jour. Ec. Ent.; Britton, W. E. 1913 12th Rept. St. Ent. of Conn. Webster, R. L. 1915. Iowa Bul. 155.

COMPOSITAE. Composite Family.

Aster cultivated. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

Cineraria sp. Ross, William A. 1914. In letter of Feb. 26, greenhouse material, "taken from flower stalks and foliage."

Lactuca sp. Davidson, W. M. 1912. Jour. Ec. Ent.

Sonchus oleraceus. Patch, Edith M. 1915. Notebook record for Sept. 15. Greenhouse material.

NOTES.

The type specimens of *solanifolii* are presumably lost. The writer once called at the Smithsonian Museum to consult Dr. Wm. Ashmead as to the possibility of referring to these and received the information that "the type is knocking around in a vial somewhere, probably dry by this time." Then he continued with cordial interest: "If you have a large green *Macrosiphum* on *Solanum* you have *solanifolii* all right."

Upon this evidence the potato pest of Maine fields was identified with the "pepper vine" aphid of Florida, after comparing it with specimens which were being determined by Mr. Pergande as *solanifolii*.

The original description of the wingless female accords with the species generally known as *solanifolii* except that "style short, conical," is hardly applicable to any mature representative of the genus concerned. For this reason it seems likely that the specimen recorded may have been in the last nymphal stage, at which time the style or cauda would be short and conical. As was customary at that time, the spur of the sixth antennal joint is designated as the seventh.

The so-called male of the original description is the winged form of some other species of aphid.

It is an interesting fact that this species, though widely known in this country as a rose aphid and existing in various collections under a commonly recognized manuscript name, has not been described from the rose, although its identity with *solanifolii* remained unsuspected and it has for some years been supposed to be an undescribed rose species.

Considering the range of food plants this aphid accepts it would be surprising if the synonymy when it is finally worked out did not contain a long list of names. It is certain that it has been recorded for *pisi* at times and it is possible that some of the food plants accredited to *pisi* really belong to the dietary of *solanifolii*.

The present paper is not concerned with the question as to whether *solanifolii* should fall as a synonym of some well known European species. It seems safer to confine the problem to America, at least until we learn to recognize this species on our own territory regardless of the foodplant from which it is collected.

LITERATURE.

1882. Ashmead, Wm. *Siphonophora solanifolii*. On the Aphididae of Florida with descriptions of new species. (Paper No. 3.). Can. Ent. Vol. 14, p. 92. Original description of apterous viviparous form. The so-called "male" is a winged form of some other species.
1905. Fletcher, James. *Nectarophora solanifolii*. Ann. Rept. on Expt. Farms for 1904, p. 228.
1907. Patch, Edith M. *Nectarophora solanifolii*. In Insect Notes for 1906. Me. Agr. Expt. Sta., Bulletin 134, p. 215.
1907. Fletcher, James. *Nectarophora solanifolii*. Ann. Rept. on Expt. Farms for 1906, p. 210.
1907. Patch, Edith M. *Nectarophora solanifolii*. The Potato Plant Louse. Me. Agr. Expt. Sta., Bulletin 147, pp. 235-257. Figs. 25-33.
1911. Patch, Edith M. *Macrosiphum solanifolii*. Two species of *Macrosiphum*. Me. Agr. Expt. Sta., Bulletin 190, pp. 81-92. Figs. 59-66. Compared with *M. destructor*.
1911. Davis, J. J. *Macrosiphum solanifolii*. List of Aphididae of Illinois. Journal of Economic Entomology, Vol. 4, p. 330.

1912. Davidson, W. M. *Macrosiphum solanifolii*. Aphid notes from California. Journal of Economic Entomology. Vol. 5, p. 411. Recorded from wild lettuce.
1912. Patch, Edith M. *Macrosiphum solanifolii*. Aphid Pests of Maine. Me. Agr. Expt. Sta. Bulletin 202, p. 178. Apparently this species collected from *Gladiolus* and cultivated *Iris*.
1913. Britton, W. E. *Macrosiphum solanifolii*, 12th Rept. of the State Entomologist of Connecticut for 1912, p. 294. Reported from leaves of corn and potatoes.
1914. Patch, Edith M. *Macrosiphum solanifolii*. Maine Aphids of the Rose Family. Me. Agr. Expt. Sta., Bulletin 233, p. Recorded from Japanese rose.
1915. Webster, R. L. *Macrosiphum solanifolii*. Potato Insects. Agr. Expt. Sta., Iowa St. Col. of Agric. and Mech. Arts. Bul. 155, pp. 400-406. Recorded from two species of wild ground cherry. (*Physalis*).

NATURAL CONTROLS.

It is always well to bear in mind concerning the injury inflicted by any plantlouse that so many elements of uncertainty enter into the career of these insects that it is quite impossible to predict whether such a pest is likely to trouble us for two or many consecutive years, or succumb to some adverse condition and practically disappear for a long time.

The weather, for instance, plays an important part in the welfare of aphids, heavy rains washing the tender forms from the plants, and cold days retarding the rate of their increase.

Certain climatic conditions are favorable to fungus parasitism which may sweep out the plantlice from a large area in a few days' time.

Then, too, in some seasons, predaceous and parasitic insects appear in numbers sufficient to render any artificial remedial measures superfluous.

REMEDIAL MEASURES.

Clean culture. Since the pink and green potato aphid passes the winter in the egg stage presumably upon a great variety of weeds near infested potato fields, the practice of fall plowing commends itself, and also the burning over of weedy places in the vicinity of potato fields in the fall or early spring. As it seems not impossible, although it has not been observed in the field, that belated individuals might under certain conditions

remain upon the potato vines and deposit overwintering eggs there, the custom common through Aroostook County of burning the old stalks is commendable in this connection.

As the aphid feeds upon a wide range of plants, the foregoing measures should be observed relative to other crops grown in rotation on the same ground.

Sprays. Cultivated roses should be sprayed with some good tobacco decoction if found to be infested with these plantlice in the spring. This is both for the health of the rose bushes as a direct measure and for the potato crop indirectly, because none of the aphids which are killed on the rose can migrate to the potato fields later on.

If the infestation upon the potato is excessive a tobacco spray for aphids might be given.

When the trouble is confined to greenhouse plants either tobacco sprays or fumigation can be resorted to according to the experience and preference of the operator.

Formula—Tobacco Decoction.

Tobacco stems or tobacco dust*..... 2 pounds.

Water 4 gallons.

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine. If whole-leaf tobacco is used prepare as above, using one pound of tobacco to each four gallons of water. No lime or other alkaline substance should be added to the tobacco *while cooking*. Apply at once or within a few days after making, if possible.

Certain reliable extracts such as "*Black Leaf*," "*Black Leaf 40*," and "*Nikoteen*" can be secured through local druggists. The *Black Leaf* preparations are manufactured by *The Kentucky Tobacco Product Company*, Louisville, Ky., and are carried by the *Collins Hardware Company*, 97 Friend St., Boston, Mass. *Nikoteen* is manufactured by *The Nikotine Manufacturing Company*, St. Louis, Mo., and can be secured from *Joseph Brick & Sons*, 47-54 N. Market St., Boston, Mass.

*Refuse from cigar factories.

There is nothing to do in the preparation of these extracts except to stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the *Black Leaf* will be found sufficient for each 70 gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in proportion of one gallon to 60 or 65 gallons of water. Careful sprayers have usually succeeded in killing plant-lice with this preparation in the proportion of one gallon to each 100 gallons of water. Thoroughness of application is of as much importance as the strength of the material.

Nikoteen is a more concentrated abstract, 1 part being used with from 400 to 600 parts of water.

Black Leaf 40 is a concentrated solution of nicotine-sulphate and is widely and successfully used in large western orchards, at the rate of 1 part to 700 or 800 parts of water. Some have been successful with 1 part to 1000 parts of water.

It is the common practice to add soap,—whale oil soap or good laundry soap at the rate of 2 bars to 50 gallons. This is to lessen the formation of drops, causing the spray to cover surfaces more in the form of a thin film.

Better success is obtained by some by using a little lime instead of soap, the inert solid in suspension aiding the extract to “wet” and “stick” to the bodies of the aphids. For the purpose 1 pound of stone lime, slaked and strained into 50 gallons of tobacco extract as prepared for application, is sufficient.

When other plant enemies besides aphids are present “Combination sprays” are frequently successfully applied. Self-boiled lime-sulphur (8-8-50 cold) may be used adding 1-70 of its volume of *Black Leaf*. On the same basis *Black Leaf* may be combined with Bordeaux (5-5-50) or with lead arsenate or with both together when foes combine against one kind of plant.

Even when the spraying is thoroughly done some of the aphids are likely to escape. Watch should therefore be kept and if the first application seems unsatisfactory, a second treatment in the course of a week is desirable.

When a small quantity of spray is required one teaspoonful of *Black Leaf 40* in one gallon of water is a convenient amount to mix.



Fig. 47. Pink and green aphid on potato stalk. Leaves covered with honey dew, honey dew fungus, and cast skins.



Fig. 48. Potato plant showing the result of 14 days infestation of plantlice on stalks which were previously healthy.

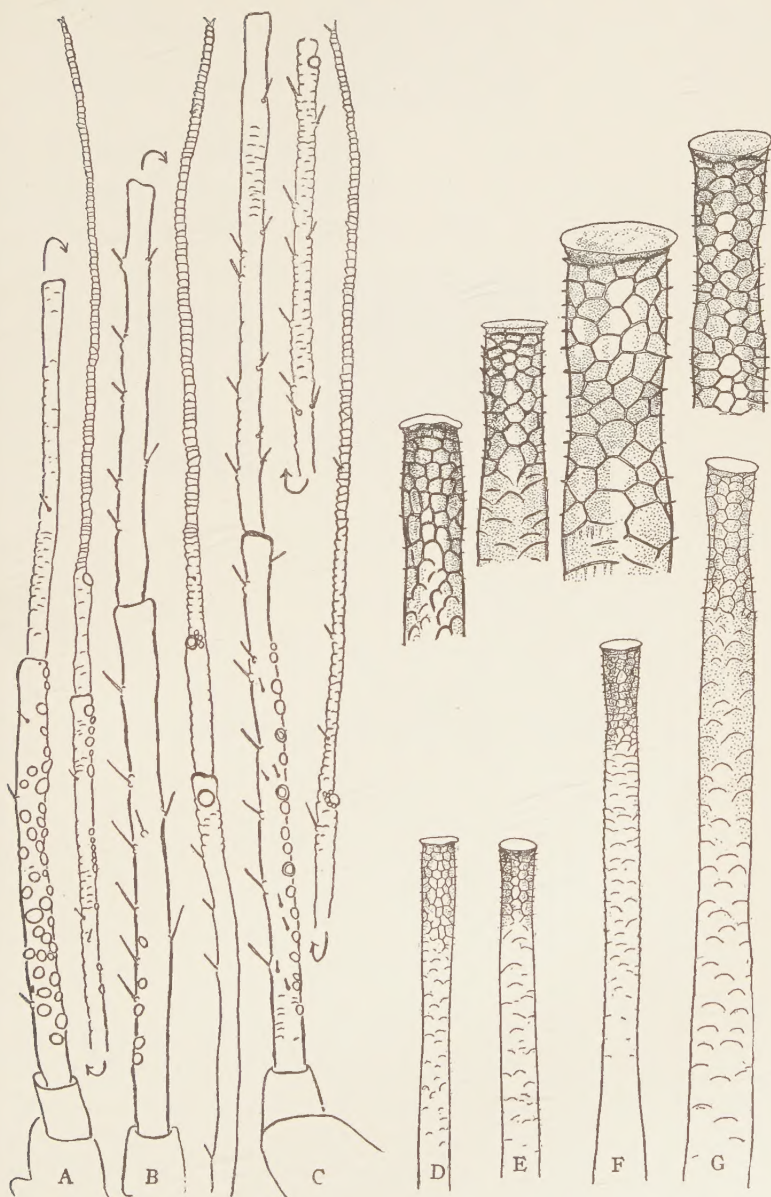


Fig. 49. *Macrosiphum solanifolii*, antennae and cornicles. A, alate male; B, apterous viviparous female; C, alate viviparous female; D, male; E, apterous oviparous female; F, alate viviparous female, pink variety; G, apterous viviparous female, green variety.

